Oncology

The masticator space. Value of computed tomography and magnetic resonance imaging in localisation and characterisation of lesions

Spazio masticatorio. Ruolo della tomografia computerizzata e della risonanza magnetica nella localizzazione e caratterizzazione delle lesioni

F. GALLI, N. FLOR, C. VILLA, G. FRANCESCHELLI, G. POMPILI, G. FELISATI[1], F. BIGLIOLI[1], G.P. CORNALBA
Radiology Unit; [1] Head and Neck Department, University of Milan, San Paolo Hospital, Milan, Italy.

SUMMARY

Aim of the study was to assess the different roles of magnetic resonance imaging and computed tomography in the evaluation of anatomical origin and pathological nature of lesions involving the masticator space. Overall 41 cases (31 computed tomography and 14 magnetic resonance imaging) of lesions involving masticator space were retrospectively reviewed by two experienced radiologists in consensus. Reference standards were histopathological results and clinical-radiological follow-up after one year. Both computed tomography and magnetic resonance imaging were performed with and without intravenous injection of contrast. Computed tomography and magnetic resonance imaging were correct in identifying the space of origin of lesions respectively in 96% and 92% of cases. Computed tomography correctly diagnosed the nature of lesions in 81% of cases and magnetic resonance imaging in 93% of cases; computed tomography and magnetic resonance imaging correctly characterized, respectively, 88% and 100% of malignant lesions and, respectively, 73% and 83% of benign lesions. In conclusion both computed tomography and magnetic resonance imaging were effective in the identification of the origin of non-extensive lesions involving masticator space. Computed tomography was more precise in depicting lesions originating from masticator space, while magnetic resonance imaging was more correct in depicting lesions originating from contiguous spaces and involving secondarily the masticator space. Magnetic resonance imaging should always be preferred to characterise lesions, nevertheless computed tomography should be chosen in cases with suspected inflammatory involvement of mandible bone.

KEY WORDS: Masticator space • Computed Tomography • Magnetic Resonance Imaging

RIASSUNTO

L'obiettivo di questo studio è stato di definire il ruolo di tomografia computerizzata e risonanza magnetica nella valutazione dello spazio d'origine e della natura delle lesioni che coinvolgono lo spazio masticatorio. Quarantuno casi (31 tomografie computerizzate e 14 risonanze magnetiche) di lesioni coinvolgenti lo spazio masticatorio sono stati retrospettivamente valutati da due radiologi con esperienza nell'imaging di testa-collo in consenso. L'esame istopatologico e il follow-up clinico-radiologico ad un anno sono stati utilizzati come metodiche di riferimento. Sia la tomografia computerizzata che la risonanza magnetica sono state eseguite sia in condizioni di base che dopo somministrazione endovenosa di mezzo di contrasto. Tomografia computerizzata e risonanza magnetica sono state corrette nell'identificare lo spazio di origine delle lesioni rispettivamente nel 96% e 92% dei casi. La tomografia computerizzata ha correttamente diagnosticato la natura delle lesioni nel 81% dei casi e la risonanza magnetica nel 93% dei casi; la tomografia computerizzata e la risonanza magnetica hanno caratterizzato con esattezza rispettivamente 88% e 100% delle lesioni maligne e rispettivamente 73% e 83% delle lesioni benigne. In conclusione, tomografia computerizzata e risonanza magnetica si sono dimostrate entrambe affidabili per l'identificazione dell'origine di lesioni non estese coinvolgenti lo spazio masticatorio. La tomografia computerizzata è stata più precisa nell'individuare l'origine delle lesioni dallo spazio masticatorio, mentre la risonanza magnetica ha ottenuto risultati migliori nell'individuare l'origine delle lesioni dagli spazi contigui. In generale, è preferibile utilizzare la risonanza magnetica per formulare la diagnosi di natura delle lesioni e utilizzare la tomografia computerizzata in caso di sospetto coinvolgimento mandibolare da patologia infiammatoria.

PAROLE CHIAVE: *Spazio masticatorio • Tomografia Computerizzata • Risonanza Magnetica*

Acta Otorhinolaryngol Ital 2010;30:94-99

Introduction

The masticator space (MS), is a large, paired antero-lateral space of supra-hyoid neck, extending from the mandibular angle to the high parietal calvarium (supra-zygomatic MS) and containing the muscles involved in mastication, posterior body and ramus of the mandible and the mandibular division of the trigeminal nerve; according to Harnsberger's classification [1], MS is located within the superficial layer of the deep cervical fascia which splits along the inferior mandible, creating a "sling" enclosing the MS [1-3]. The medial fascial slip runs along the deep surface of the pterygoid muscles and inserts on the undersurface of the skull base just medial to the *foramen ovale*; the lateral slip covers the surface of the masseter muscle, attaching to the zygomatic arch, and continues cephalad over the surface of the temporalis muscle to the top of the suprazygomatic MS; no horizontal fascia exists deep to the zygomatic arch [1-3].

MS is difficult to explore only by means of clinical examination; imaging techniques, such as Magnetic Resonance Imaging (MRI) and Computed Tomography (CT), are, therefore, essential in order to correctly evaluate this district [2-4].

The purpose of this study was to assess the different roles of MRI and CT in the evaluation of anatomical origin and pathological nature of lesions involving the MS, reviewing a number of selected MRI and CT cases, with the aim of providing practical advice to simplify the diagnostic process.

Material and methods

Population

A retrospective evaluation was made of all the head and neck CT and MRI examinations performed in the Hospital between January 2007 and December 2008, searching for disease involving the MS. Finally, 41 cases were selected and considered in the present investigation.

The study population comprised 41 patients, 24 male, 17 female, age range 15-85 years, mean 53 years, who underwent MRI and CT examinations. Overall, 31 patients underwent CT examination, 14 patients underwent MRI; 4 patients underwent both CT and MRI.

CT and MR technique

All CT examinations were performed with a 4-detector scanner (LightSpeed QX/I, General Electrics Medical System, Milwaukee, WI, USA) with the following protocol: detector configuration 4 x 1.25; table-feed 3.75; pitch 3; Kv 120; mA 150. Intravenous injection of iodinated non-ionic contrast agent (Iomeron, 350 mg/ml, Bracco S.p.A., Milan, Italy) for a total of 90-100 ml, with a flow injection of 2.5 ml/min was carried out in all cases. An arterial phase acquired at 20-25 seconds and an equilibrium phase acquired at 70 seconds after contrast administration were available. Multi-planar reconstruction was carried out for each examination (slice thickness 1.25 mm, interval 1.25 mm) using a satellite workstation (Advantage Windows 3.1, GE Healthcare, Slough, Bucks, UK).

All MRI examinations were performed with a 1.0 T scanner (Philips NT Intera, Philips Medical Systems, Best, The Netherlands). The examination protocol consisted of coronal and transverse sequences with a slice thickness of 4-5 mm, SE T1 (TE 15, TR 536), FSE T2 (TE 120, TR 4500) and T1 FATSAT (TE 25, TR 1280) weighted. In all cases, T1 FATSAT sequences obtained after intravenous administration of a paramagnetic contrast agent (Gadopentetate dimeglumine, 469 mg/ml, Magnevist – Bayer, Leverkusen, Germany – 0.2 ml per kg of body weight) were available.

Imaging analysis

Two radiologists with 13 and 5 years of experience in head and neck imaging, retrospectively, evaluated all the CT and MRI examinations in consensus in order to determine the space of origin and the pathological nature of the lesions.

Following Harnsberger's criteria [1-3], a lesion was considered to originate from the MS when its centre was located within the mastication muscles or mandibular ramus and/or when the lesion displaced the para-pharyngeal space from anterior to posterior.

The following radiological criteria were taken into account in the characterization of lesions. Malignant lesions were presumed to show CT and MR contrast-enhancement, infiltration of surrounding soft tissues beyond the MS, infiltration of the mandibular bone and possible perineural spread.

Inflammatory lesions were presumed to show absent or peripheral CT and MR contrast-enhancement; the correct diagnosis was sometimes suggested in the presence of inflammatory causes (i.e., adjacent odontogenic abscess, salivary stones) on the same examination.

Further criteria were taken into account in the characterisation of a lesion by means of MRI: neoplastic lesions were presumed to be heterogeneously hyperintense on T2 sequences; inflammatory lesions were presumed to be strongly hyperintense on T2 sequences, showing a signal similar to fluid, with possible findings of cellulitis, myositis and fasciitis associated [2].

In order to establish a diagnostic hypothesis, patient's age, symptoms and case history were also considered.

Reference standard

Histopathological examination and clinical-radiological follow-up were considered as reference standards. Histopathology was available in 32/41 (78%) patients who underwent surgery. For the other nine patients, clinical and radiological one-year follow-up was considered.

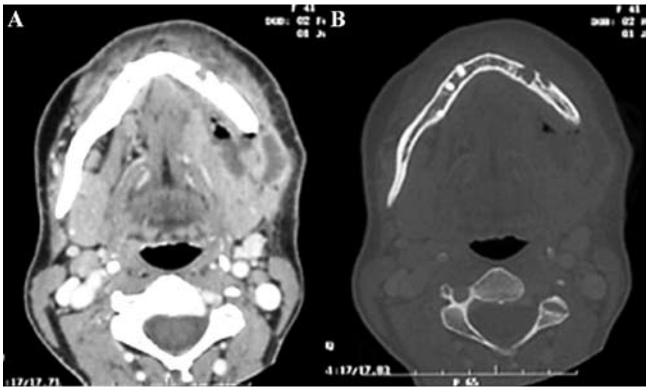

Fig. 1. A 41-year-old female affected by an odontogenic abscess in left MS, seen as a non homogeneous hypodense mass located within muscles of mastication (A), correctly diagnosed by CT. The origin of the infection from a fistulizing paradontal socket was clearly identified using CT bone window (B).

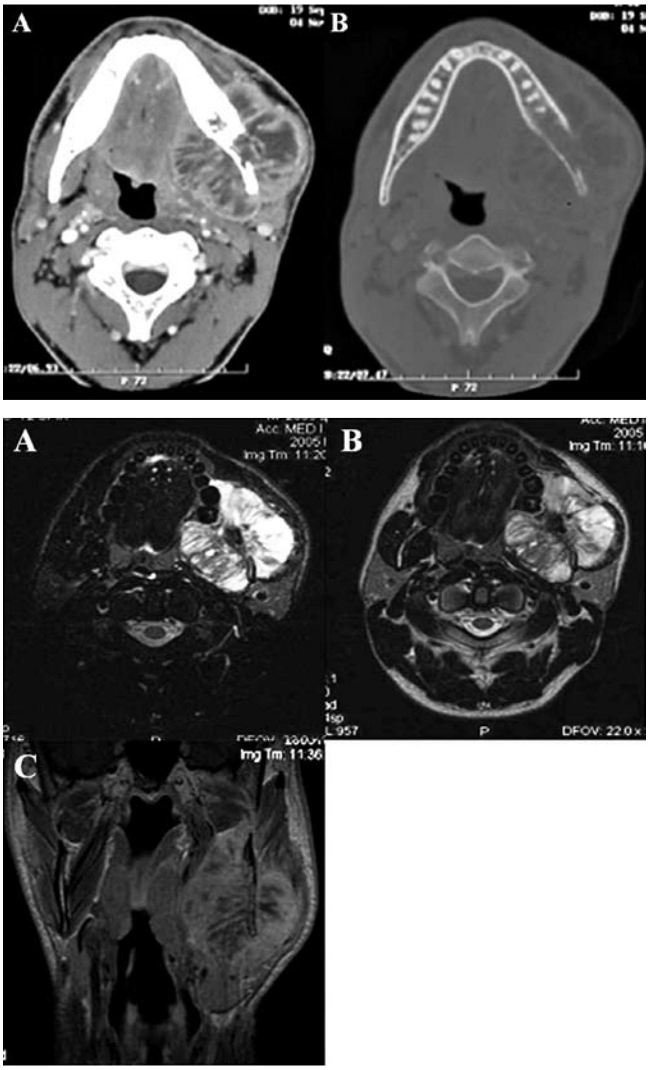

Fig. 2. A 32-year-old male affected by bulky osteosarcoma originating from left posterior body of mandible, completely enclosed within MS by fascial layers, correctly diagnosed by both CT (2.1: A. soft tissue window; B. bone window) and MRI (2.2: A. axial STIR sequence; B. axial T2 weighted sequence; C. coronal T1 weighted sequence after gadolinium administration).

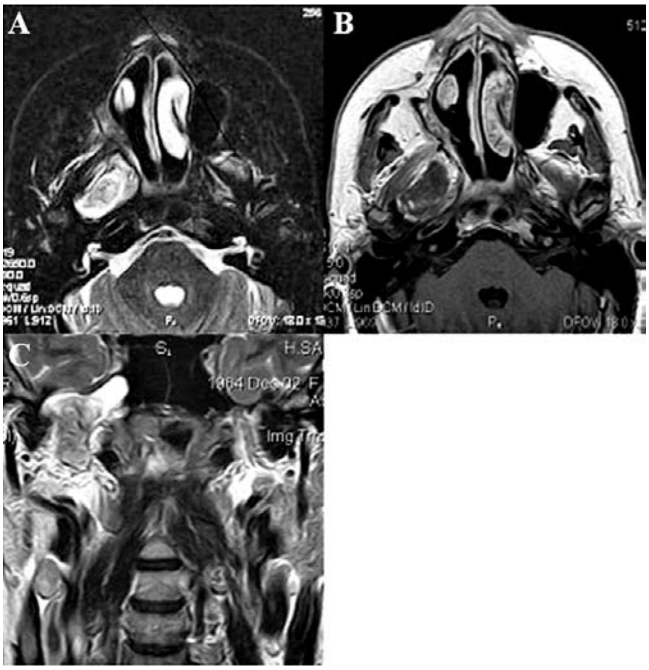

Fig. 3. A 40-year-old female affected by a schwannoma occupying entire right parapharyngeal space and involving MS, incorrectly classified as a lesion originating from parotid space by MRI (A. axial STIR sequence; B. axial T1 weighted sequence after gadolinium administration; C. coronal T2 weighted sequence). Lack of identification of surrounding parapharyngeal fat displacement due to massive extension of lesion probably led to erroneous interpretation.

Results

In 24 out of 25 (96%) cases, CT examination correctly identified the origin of the lesions. CT was incorrect in one case of a salivary gland tumour involving, secondarily, the mandible, erroneously interpreted as a lesion originating from the mandible, within the MS. Of the 31 cases, 6 were excluded on account of the massive extension of the lesions (2 abscesses, 2 tumour recurrences, 1 fibrous dysplasia, 1 radiation-induced inflammation). CT showed a sensitivity of 100% in diagnosing lesions originating from the MS (examples in Figures 1 and 2a) and of 90% in detecting lesions originating from contiguous spaces and involving secondarily the MS.

In 11 out of 12 (92%) cases, MRI correctly identified the space of the origin of the lesions. As already mentioned for CT, we excluded 2 out of 14 cases investigated with MRI, because of the massive extension of the lesions (one tumour recurrence, one lymphangioma). MRI was correct in 80% of the lesions originating from MS (Fig. 2b) and in 100% of the lesions originating from contiguous spaces and involving the MS. MRI was not correct in one case of schwannoma, incorrectly interpreted as a parotid space lesion (Fig. 3).

The results of CT and MRI as far as concerns characterisation of lesions are detailed, respectively, in Tables I and II. CT correctly diagnosed the nature of lesions in 25 out

Table I. CT cases. CT hypothesis regarding pathological nature of lesion and final diagnosis provided by reference standard are shown. Errors in CT are reported in capital letters.

Case	CT diagnosis	Final diagnosis
1	Abscess	Confirmed at 1-year follow-up
2	Hard palate malignant lesion	Confirmed at 1-year follow-up
3	Parotid gland malignant lesion	Parotid gland carcinoma
4	Parotid gland malignant lesion	Parotid gland carcinoma
5	Trigonal malignant lesion	Trigonal sarcomatoid carcinoma
6	MANDIBLE PRIMITIVE MALIGNANT LESION	Metastasis from prostate cancer
7	MANDIBLE MALIGNANT LESION	Osteitis in osteopetrosis
8	MANDIBLE MALIGNANT LESION	Fibrous dysplasia
9	TRIGONAL MALIGNANT LESION	Trigonal squamocellular carcinoma
10	Mandible secondary malignant lesion	Metastasis from lung cancer
11	Recurrent lesion	Tongue undifferentiated carcinoma
12	Odontogenic abscess with pterygoid internal muscle involvement	Confirmed at 1-year follow-up
13	Oral cavity malignant lesion	Mandible squamous cell carcinoma
14	Abscess with pterygoid internal muscle involvement	Confirmed at 1-year follow-up
15	Abscess	Abscess
16	Masseter cyst	Confirmed at 1-year follow-up
17	MANDIBULAR ABSCESS	Mandible squamocellular carcinoma
18	MANDIBLE MALIGNANT LESION	Salivary gland mucoepidermoid carcinoma
19	Masticatory muscles odontogenic inflammation	Confirmed at 1-year follow-up
20	Mandibular benign lesion	Fibrous dysplasia
21	Odontogenic abscess within masticatory muscles	Abscess
22	Mandibular inflammatory lesion	Radiation-induced osteitis
23	Abscess	Confirmed at 1-year follow-up
24	PAROTID MALIGNANT LESION	Abscess
25	Malignant lesion over masseter	Malignant lesion from salivary gland
26	Abscess	Confirmed at 1-year follow-up
27	Mandibular cyst	Recurrent keratocyst
28	Palate malignant lesion	Adenoid cystic carcinoma
29	Malignant recurrence in masticatory muscles	Eyelid recurrent squamous carcinoma
30	Mandible primitive malignant lesion	Mandible osteosarcoma
31	Oropharynx malignant lesion	Spinocellular carcinoma

of 31 cases (81%) and MRI in 13 out of 14 cases (93%). CT was incorrect in 6 cases: metastasis from prostatic tumour, salivary gland tumour, fibrous dysplasia, and osteitis in osteopetrosis, all erroneously described as primitive mandibular lesions, one case of mandibular squamous cell carcinomas misinterpreted as an abscess and one case of abscess incorrectly described as a malignant parotid lesion. MRI was incorrect in a case of schwannoma, already mentioned above.

Discussion

MS evaluation is not always possible only by means of clinical examination and, therefore, imaging techniques are crucial in order to provide an accurate diagnosis of lesions involving the MS. In the last few decades, MRI had been considered the technique of choice for suprahyoid neck spaces study, on account of the accuracy in soft tissue evaluation and multiplanarity. Recent advancements in CT imaging, such as isotropic imaging and multiplanar reconstructions, have improved the use of CT in the assessment of head and neck lesions, including lesions involving MS; moreover, CT has been shown to be more accurate in bone evaluation [5-8]. It was, therefore, interesting to compare the efficacy of CT and MRI in the detection of origin, and in the characterisation, of MS lesions.

Both CT and MRI were found to be accurate in depicting the origin of lesions from MS. Probably, the availability

Table II. MRI cases. MRI hypothesis regarding pathological nature of lesion and final diagnosis provided by the reference standard are reported. MRI errors are shown in capital letters.

Case	MRI diagnosis	Final diagnosis
1	Angiomatous lesion with fibrosis	Lymphangioma
2	Recurrent pleomorphic adenoma anterior to masseter	Pleomorphic adenoma
3	Abscess	Abscess
4	Recurrent parotid gland malignant lesion	Recurrent parotid gland adenocarcinoma
5	Recurrent parotid gland adenocarcinoma	Confirmed at 1-year follow-up
6	Parotid gland malignant lesion	Parotid gland undifferentiated carcinoma
7	PAROTID PLEOMORPHIC ADENOMA	Schwannoma
8	Fibroadipose tissue within infra-temporal fossa	Fibroadipose tissue
9	Mandible primitive malignant lesion	Mandible osteosarcoma
10	Hypertrophic parotid gland due to controlateral agenesis	Confirmed at 1-year follow-up
11	Palate malignant lesion	Adenoid cystic carcinoma
12	Malignant recurrence in masticatory muscles	Eyelid recurrent squamous cell carcinoma
13	Mandible primitive malignant lesion	Mandible osteosarcoma
14	Oropharynx malignant lesion	Spinocellular carcinoma

of multiplanar submillimetric reconstructions resulted in CT being the more accurate of the techniques. The origin of small lesions was easier to identify, as it was possible to describe the centre of the lesion and the displacement of parapharyngeal fat. In all the lesions originating from the MS, both CT and MRI showed dislocation of parapharyngeal fat from the anterior to the posterior area, which was a typical feature of this kind of lesion. It was not possible to assess this feature in cases presenting extensive lesions and was, therefore, demonstrated to be less useful in these situations [1-3]. A case of schwannoma occupying the entire parapharyngeal space and involving the MS was incorrectly classified as a lesion originating from the parotid space by means of MRI, probably because of its considerable extension and the lack of identification of surrounding fat displacement.

This study also confirmed the reliability of both CT and MRI in the characterisation of lesions involving the MS.

MRI was shown to be more effective than CT in identifying malignant lesions (correct diagnosis in 100% of cases); this might be due to the high contrast resolution of MRI in studying soft tissues, according to the literature [5]. The following criteria were evaluated in order to differentiate malignant from benign lesions: presence of mandibular erosion and extension of the lesion beyond the surrounding fascial layers. Bone erosion was demonstrated to be common in cases of malignant lesions but it might be found also in cases of benign lesions such as radiation-induced inflammation or osteoradionecrosis [6-8]. Involvement and disruption of fascial layers should always be investigated when suspecting a malignant lesion, as it is commonly associated with aggressive neoplasms [9]; nevertheless, in some situations, extensive inflammatory lesions were shown to develop outside the fascial layers, mimicking a tumour both on CT and MRI scans. In the present investigation, some neoplastic lesions originating from contiguous spaces and involving the MS invaded the deep cervical fascia, while some large neoplastic lesions, which showed high grade malignancy at the histopathological examination, were completely confined to the MS, without evidence of fascial disruption.

MRI was shown to be more effective than CT also in characterising benign inflammatory lesions, although in this circumstance results are similar. In the case of inflammatory lesions, from a clinical point of view, it was crucial to determine the extent of the lesions, to describe abscesses, and to detect potential mandibular osteomyelitis or skull base infections, in order to plan appropriate treatment [6 10 11]. MRI more accurately delineated inflammation involving soft tissues, in particular muscles, because of the high contrast resolution, as already mentioned above [5]. However, it should be pointed out that, in patients with inflammatory involvement of the mandibular bone, CT was more helpful in depicting osteomyelitis and in diagnosing the possible origin of infections (i.e., adjacent odontogenic abscess, salivary stones), on account of the routine use of bone window CT images [12]. On the other hand, CT was not reliable in the differential diagnosis between primitive or secondary mandibular bone lesions: four out of the six cases incorrectly characterised by means of CT were mandibular lesions misinterpreted.

According to the literature, MRI was shown to be more effective in representing the perineural spread of neoplasms [3]; in this study, both CT and MRI correctly illustrated all six cases of macroscopic perineural invasion, but since the number of cases is limited it is impossible to express a judgment on this issue.

The value of both CT and MRI, in the study of MS anatomy, and, in particular, in the identification of the origin of non-extensive lesions, was confirmed. This experience revealed that CT was more precise in depicting lesions originating from the MS, due to the availability of submillimetric imaging, while MRI was more correct in depicting lesions originating from contiguous spaces and involving the MS. MRI should be chosen in order to characterise lesions, due to its high contrast resolution for soft tissues which is helpful in detecting malignant lesions. Nevertheless, CT should be preferred in those cases of probable inflammatory involvement of the mandible, as it is more effective in defining bone infections and, in the majority of cases, able to reveal the starting point of inflammation.

It is, therefore, once again crucial to collect exhaustive information about patient's symptoms and history in order to offer a reasonable diagnostic hypothesis [10]. This would lead to the optimal choice between two expensive second-level examinations and would probably make the diagnostic pathway not only simpler but also less time-consuming and, consequently, the management of patients with MS lesions.

To differentiate between benign and malignant lesions, it will be interesting to study differences in the apparent diffusion coefficient (ADC) values of MR 3T field strength imaging; some Authors [13 14] have already reported significant differences between ADC values in benign and malignant head and neck lesions, but more studies are required in daily clinical application.

References

1. Harnsberger HR, Osborn AG, MacDonald J, et al., editors. *Diagnostic and surgical imaging anatomy: brain, head & neck, spine*. Salt Lake City (UT): Amirsys 2006.
2. Harnsberger HR, Hudgins PA, editors. *Diagnostic imaging: head and neck*. Salt Lake City (UT): Amirsys 2004.
3. Harnsberger HR. *Handbook of head and neck imaging. Handbook in Radiology series, 2nd edition*. Chicago (IL): Mosby 1995.
4. Aziz MA, Cowie RJ, Skinner CE, et al. *Complete pterygoidectomy – a novel method for the topographical investigation of the deep masticator space and its contents*. Clin Anat 2001;14:354-62.
5. Jones KC, Silver J, Millar WS, et al. *Chronic submasseteric abscess: anatomic, radiologic and pathologic features*. Am J Neuroradiol 2003;24:1159-63.
6. Connor SE, Davitt SM. *Masticator space masses and pseudomasses*. Clin Radiol 2004;59:237-45.
7. Chong J, Hinckley LK, Ginsberg LE. *Masticator space abnormalities associated with mandibular osteoradionecrosis: MR and CT findings in five patients*. Am J Neuroradiol 2000;21:175-8.
8. Hariya Y, Yuasa K, Nakayama E, et al. *Value of computed tomography findings in differentiating between intraosseous malignant tumors and osteomyelitis of the mandible affecting the masticator space*. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2003;95:503-9.
9. Kimura Y, Sumi M, Sumi T, et al. *Deep extension from carcinoma arising from the gingiva: CT and MR imaging features*. Am J Neuroradiol 2002;23:468-72.
10. De-Vincente-Rodriguez JC. *Maxillofacial cellulites*. Med Oral Patol Oral Cir Bucal 2004;9(Suppl.):133-138;126-133.
11. Flynn TR, Shanti RM, Levi MH, et al. *Severe odontogenic infections. Part 1: Prospective report*. J Oral Maxillofac Surg 2006;64:1093-103.
12. Obayashi N, Ariji Y, Goto M, et al. *Spread of odontogenic infection originating in the maxillary teeth: computerized tomographic assessment*. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004;98:223-31.
13. Shah GV, Wesolowski JR, Ansari SA, et al. *New directions in head and neck imaging*. J Surg Oncol 2008;97:644-8.
14. Srinivasan A, Dvorak R, Perni K, et al. *Differentiation of benign and malignant pathology in the head and neck using 3T apparent diffusion coefficient values: early experience*. Am J Neuroradiol 2008;29:40-4.

Received: January 20, 2010 - Accepted: February 20, 2010

Address for correspondence: Dr.ssa F. Galli, Unità Operativa di Radiologia Diagnostica e Interventistica, Università degli Studi di Milano, Azienda Ospedaliera San Paolo, via A. di Rudinì 8, 20142 Milano, Italy. Fax: +39 02 50323393. E-mail: federica.galli@fastwebnet.it